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The microcomputer connection to local networks

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Personal computers—as typified by the Apple—together with integrated software and a high-level language are the keystones of this 240-kbit/s local network.

High hardware costs and a lack of integrated software are two major barriers to widespread use of local networks in the business environment. By emphasizing low-cost hardware and a systems approach, some network manufacturers are breaking down these barriers without abandoning their original commitment to the development of flexible, high-function networks.

Sophistication in networking today is achieved through integrated-software development. In a network architecture, networking software is at the lowest level, high-level languages and the operating system are at the next-higher level, and the application software is at the highest level. Integrated software results in each level being transparent to all levels above and being able to embed in itself the next lower level. It makes all network resources available to application programs on a turnkey basis.

However, linking computers with integrated software in a network is no easy task. Communications software has inherent design problems. For example, although the Basic programming language is available for most microcomputers, a Basic program written to use a particular disk that runs on one microcomputer usually will not run on another. Microcomputer manufacturers implement different dialects of the Basic language, using interpreters specially designed for their particular machines. (Interpreters are programs that read other programs and carry out their instructions.) Consequently, application programs written for network use must be replicated or reworked to accommodate each type of computer that will use the network—at considerable cost in development time.

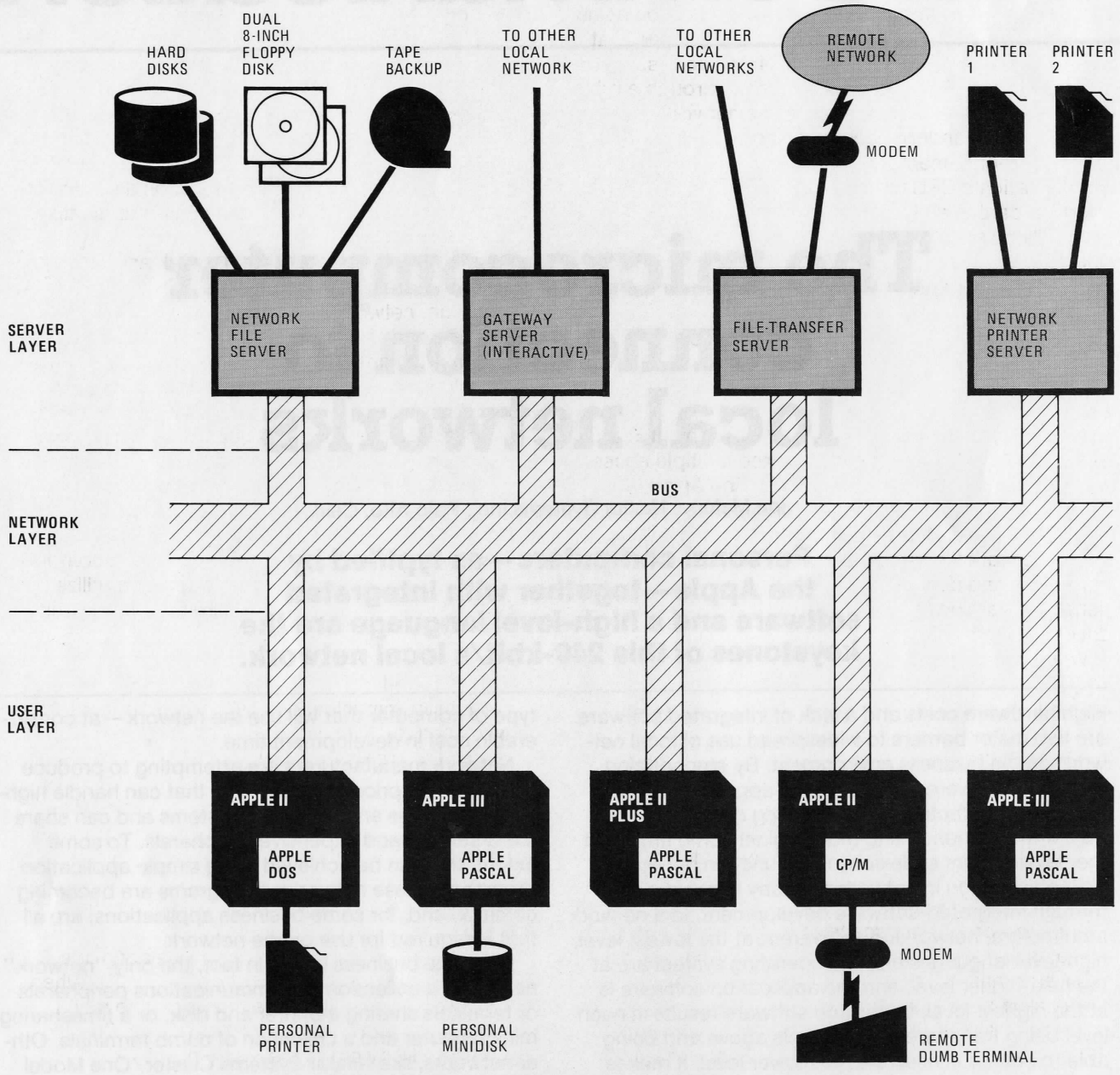
Network manufacturers are attempting to produce competitively priced components that can handle high-level languages and operating systems and can share mass storage and expensive peripherals. To some extent, this can be achieved using simple application programs. These networking programs are becoming common and, for some business applications, are all that is required for use on the network.

For some business users, in fact, the only "network" needed is a collection of communications peripherals or terminals sharing a printer and disk, or a timesharing minicomputer and a collection of dumb terminals. Other networks, like Nestar Systems Cluster/One Model A, are built for business applications that take advantage of an integrated computing/communications environment, with application programs written to fill specific needs.

Companies that want to add more and more applications to their networks must first make the choices that center around cost. Sophisticated software appropriate for the office environment does not necessarily require high-end hardware. In fact, much networking hardware today is wasted: The user will never need the speed available.

A network built around personal computers (typically 8-bit machines with 64 kbytes of memory) has a set of cost goals and decisions different from a larger computer network's. The network hardware and software

1. An Apple "tree." *Each personal computer in the Nestar local network is independent and can function as a standalone workstation. The operating system may be Apple DOS, Apple Pascal, or CP/M. Some of the microcomputers function as file- or print servers. Network topologies may be straight-line bus, star, tree, and daisy-chain.*



must be designed to cost much less than the personal computers themselves, while network speed and bandwidth must support the personal computer tasks.

These cost and performance factors lead naturally to the choice of simple, programmable hardware for interfacing chores, with most of an interface unit's function executed in software. If the network's software base is adequate, such a network is appropriate for use in office environments that require graphics and text processing, the automation of simple tasks, and strong interstation communications.

Nestar's Cluster/One Model A network is built around as many as 65 Apple microcomputers (Fig. 1). Some function as user workstations; others are dedicated as file or print servers. The operating system may be Apple DOS, Apple Pascal, or CP/M from Digital Research, Pacific Grove, Calif. User Apples share mass storage and printers, but each machine is independent and can function as a standalone workstation, using its own minidisk drives and printers. The failure of any machine will not bring down the network. (Figure 1 does not show remote modems, which are assumed to be part of the remote interfacing devices.)

Stations are connected by 16-wire cable (flat ribbon,

twisted pairs, or round shielded bundle) and can be configured in any sequence and topology spanning 1,000 feet without repeaters. The addition of repeaters every 1,000 feet permits a total length of 3,000 feet. Straight-line bus, star, tree, and daisy-chain topologies are allowed. The fastest data transmission speed that can be used with these topologies is 240 kbit/s.

Each workstation accesses the cable through a printed-circuit interface card that contains network bus drivers, RAM (random-access-memory) buffers, and ROM (read-only-memory) code. This code is executed by the station's CPU to access the network. With an interface card in an I/O slot, commands that would ordinarily be sent to a local peripheral by the machine's operating system are sent instead to another, dedicated, Apple that receives the I/O commands and, for example, accesses a hard disk instead of a local floppy. This implementation of "virtual I/O" helps make the network transparent to users.

Design decisions

Cluster/One is Ethernet-like in its philosophy: It is a baseband network using carrier-sense multiple access with collision detection (CSMA/CD). The Apple was selected because it was judged the most economical and dependable off-the-shelf model.

The network file servers each support two 33-Mbyte hard disks and dual 8-inch floppy-disk drives. High-density streaming (continuous-loop) cartridge-tape drives, driven by Nestar software, are used for backup.

When a user-station Apple is turned on, the auto-start ROM on the computer's main circuit board searches the machine's peripheral slots for disk-controller cards. The Nestar interface card, disguised as a controller card, is discovered, and the Apple transfers control to it. The interface card notifies a designated file-server Apple on the network that the station is active, and a program is bootstrap-loaded (self-loaded and automatically sequenced) into the station's RAM.

User's choices

The loaded program is specified in a network file that contains a profile of each user station. Such profiles allow automatic startup of user-application programs. The default program allows the user to key in the name of the program to be loaded by identifying the virtual disk on the file-server disk to be bootstrapped. In this way, the user can also choose the local operating-system environment to be loaded.

The file server's shared hard disks and floppy disks are organized into a collection of directories and virtual disks. These may be bootstrap-loaded and are formatted for use in the operating systems available to Apple users. Virtual disks are created, "mounted," named and renamed, and otherwise manipulated using an application program executed from the local operating system. In this way, network operations are transparent to the user. Because network application programs and operations are accomplished via high-level languages, the user does not have to penetrate more than one level of software to reach his data.

When bootstrap-loading from a virtual disk, the network loads the required language and operating software into the local machine and follows any startup (HELLO) program instructions on the disk. If the disk is a DOS Basic type, for example, a Basic prompt will appear on the screen, just as with a standalone terminal. The local machine can then mount up to 255 variable-size (virtual) disks at multiple file servers, and code files, text files, and binary data on them can be accessed. Cluster/One currently supports up to 66 Mbytes of hard-disk memory per file server and up to six printers per print server. An arbitrary number of file servers and print servers may be used on a single network. The print server may be connected to multiple, separate networks.

In turnkey applications, both network and operating-system software must be transparent. In Cluster/One, at power on, network and operating-system bootstrap programs read files that may contain preset auto-startup instructions. The application program will then be downloaded into the machine automatically.

Security and the maintenance of data integrity are provided through a series of cooperative locks, password options, and the auto-start capability. Additionally, users can encrypt data at their stations before sending it to a file server. Application programs such as Visicalc (from Personal Software Inc., Sunnyvale, Calif.) and DB Master (from Stoneware Microcomputer Products, San Rafael, Calif.) are adapted to utilize network virtual I/O, which allows shared read-only and exclusive read/write access.

Electronic mail

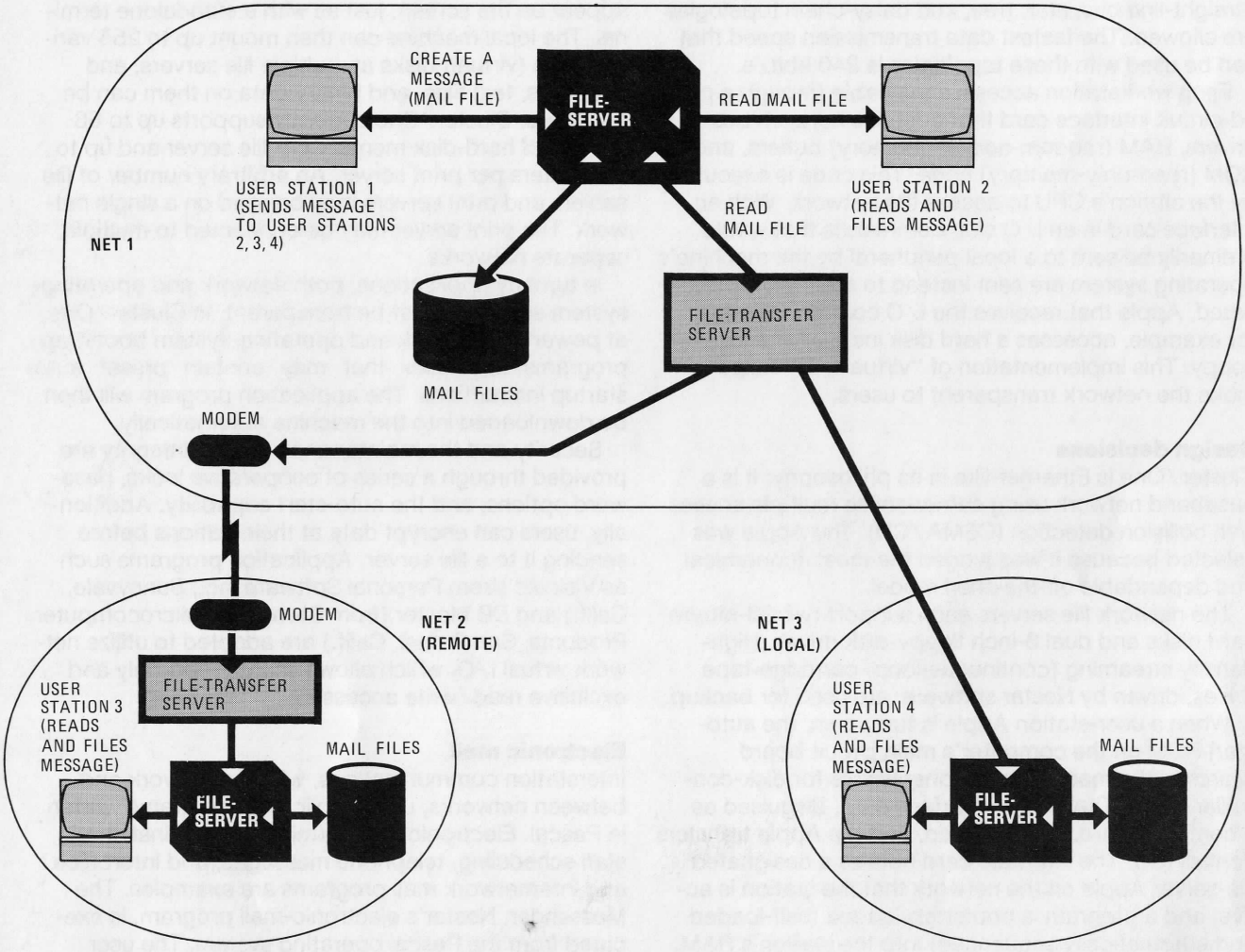
Interstation communications, within a network and between networks, uses application programs written in Pascal. Electronic talk (terminal-to-terminal chat), staff scheduling, telephone messages, and interoffice and internetwork mail programs are examples. The Messenger, Nestar's electronic-mail program, is executed from the Pascal operating system. The user sends and receives workstation messages, files them according to class, forwards and answers them, and writes them to files or directs them to printers.

The network accomplishes this by creating and deleting files on the shared hard disks (Fig. 2). When a user composes and sends a message, the mail program creates a new mail file on a hard disk. This file contains the body of the message, preceded by a header with information such as the date and time the message was composed, the sender, the subject, and the recipient. When the recipient checks for new mail, the network reads the newly created file and places its contents in the workstation buffer. The message can then be filed, written to a permanent file, printed, forwarded, answered, or otherwise manipulated.

Modular software

Once created, the software that sends and receives messages exists as a module to be used over the network in various other application programs. In the same way, other modules are written, such as a "menu I/O" unit that causes a list of choices to be displayed to the user and input from the user to be accepted when var-

2. Carrying the electronic mail. *Interstation communications uses application programs written in Pascal. The user sends and receives messages, files them according to class, forwards and answers them, and writes them to files or directs them to printers. The network creates and deletes files on the shared hard disks.*



ious application programs are run. As the number of such available modules increases, the time spent to create new programs decreases.

There are two prerequisites for maximum modular program development: (1) network software that allows network transactions to be generated by a high-level operating system and (2) workstation machines sufficiently alike and sophisticated (with enough RAM and using a high-level language such as Pascal) to accommodate the software without being modified.

Nestar maintains a developmental multinetwork that currently links three networks at the company's Palo Alto facility with three networks at Zynar Inc., in Uxbridge, England, and a network at Morris Decision Systems, in New York City. The only additional hardware required for this implementation is a pair of comparatively inexpensive modems or acoustic couplers for the Uxbridge and New York connections. Remote dumb terminals (keyboards and screens) can also access assigned user stations via modems.

The networks interface in several ways. Application programs that rely on the manipulation of message and request files to transfer information between terminals operate as if on a single network: An Apple dedicated as a file-transfer server (FTS), connected to the three local networks, transfers the files from a file server/hard disk on one network to the file server on another. In this way, print requests and internetwork mail, for example, can move from one network to another. In a second, similar implementation, two FTS Apples communicate over the phone to exchange mail and other text and code files.

Interactive modes of interstation communications require a gateway server—a dedicated Apple running a packet-transfer program that moves transmissions between user stations on one network and file-server Apples on another. The gateway server handles digital data in real time. The user changes, by command, the server to which his network messages are sent. Instead of the file servers on his own network, he uses those of another. Of course, each network's password and locking security remain in force. ■